Using Automatic Dependent Surveillance Broadcast (ADS-B) and Other Technologies to Enhance Safety and Efficiency in the NAS

Presented to:
ICNS Conference

AND-500
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May 21, 2003
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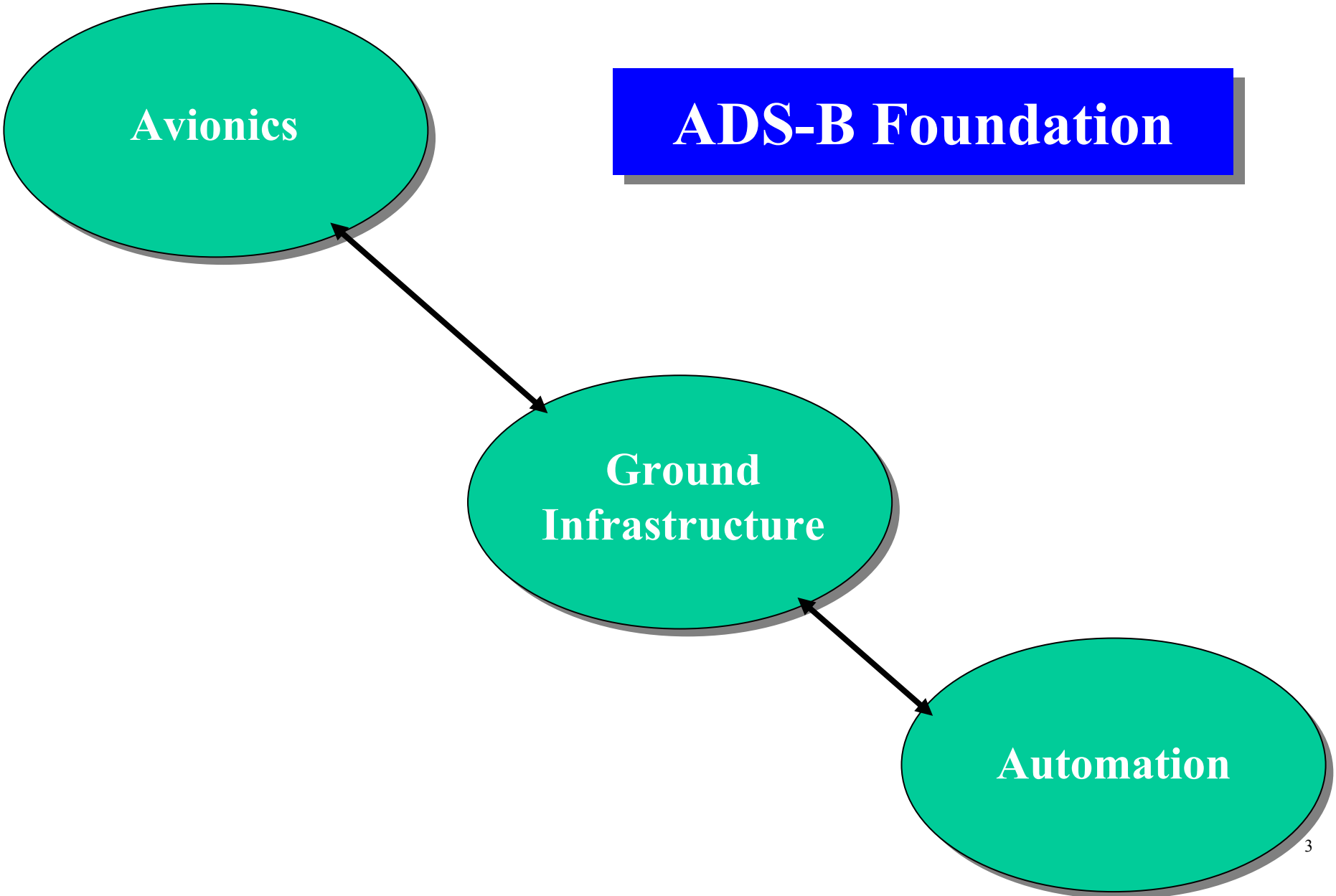
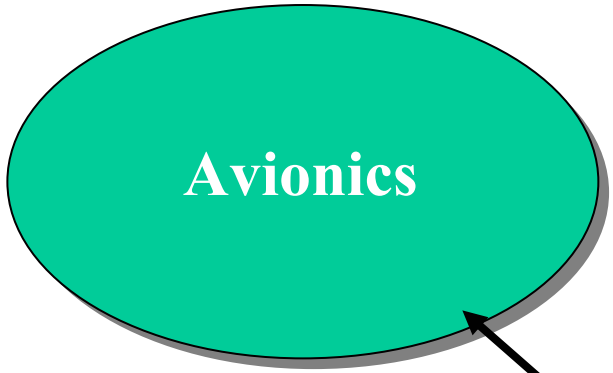
Automatic Dependent Surveillance Broadcast (ADS-B)

- Foundation
- Services Portfolio
- Transition to Implementation

ADS-B Foundation



Foundation For ADS-B Implementation

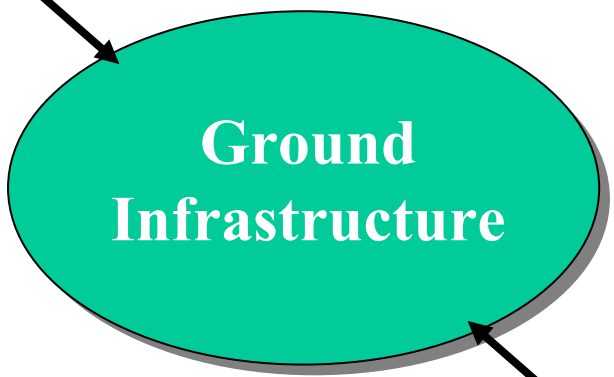


Air Transport Avionics
- ACSS L-3 Communications
  - Transponder XS-950 Commercial
  - Transponder XS-950S/I Military
- Honeywell
  - CAS 67A TCAS II
- Rockwell Collins
  - TDR-94/94D Mode S Transponder
  - TPR-901 Mode S Transponder
- UPS-AT
  - LDPU
  - Transponder

General Aviation Avionics
- Garmin
  - GTX-330 Mode S Transponder
- UPS-AT
  - MX-20
- Honeywell
  - KT-73

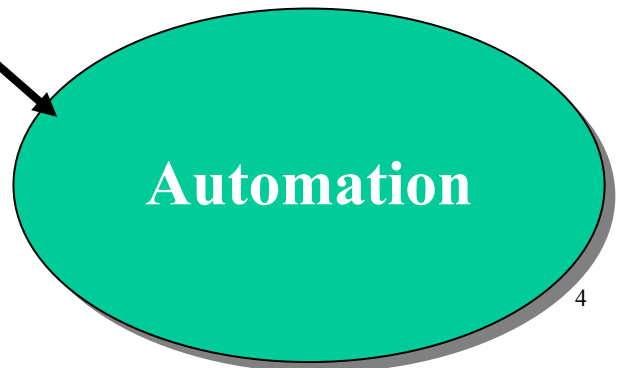
Airframes
- Boeing (March 2004)
- Airbus (March 2003)

Vehicles
- Trios (2003)
- Sensis (2002)



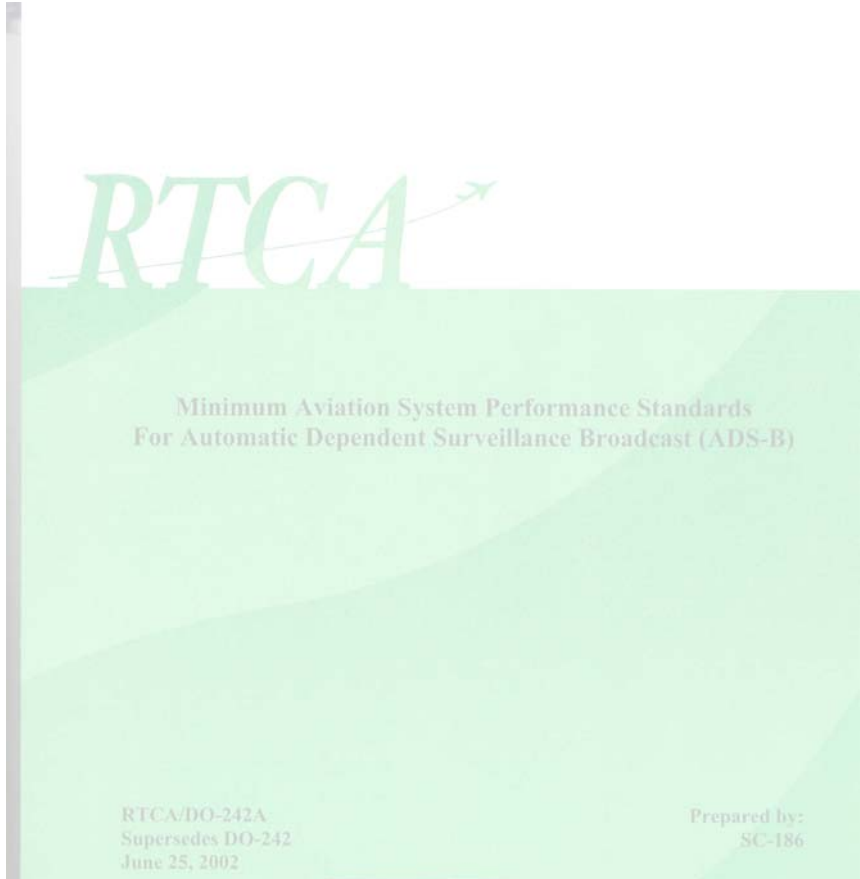
Ground Infrastructure
- Prototype
  - UPS-AT GBT (1999)
  - Sensis ASDE-X (1999)
- Production
  - ASDE-X (2005/2006)
  - Capstone (2004)
  - Standalone Ground Stations (2005)

Automation
- Terminal
  - CommonARTS (2004)
  - STARS (2005)
  - SATDS (2004/2005)
- EnRoute/Ocean
  - MicroEARTS (2001)
  - ERAM (2007/2008)
  - ATOP (2006)
- Surface
  - ASDE-X (August 2003)
- Flight Following (2002)

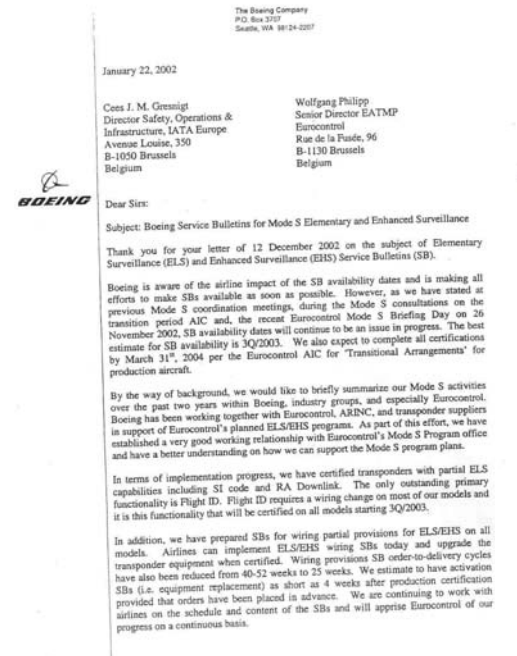


ADS-B Standards Development

- DO-272 User Requirements for Aerodrome Mapping: October 2001
- ADS-B Minimum Aviation System Performance Standards (MASPS) Revision A: April 2002
- Universal Access Transceiver (UAT) Minimum Operations Performance Standard (MOPS): June 2002
- ADS-B 1090 MHz MOPS Rev A: April 2003
- TIS-B MASPS: April 2003



ADS-B: Boeing and Airbus Committed



The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

January 22, 2002

Cees J. M. Gresnigt
Director Safety, Operations & Infrastructure, IATA Europe
Avenue Louise, 350
B-1050 Brussels
Belgium

Wolfgang Philipp
Senior Director EATMP
Eurocontrol
Rue de la Fusée, 96
B-1130 Brussels
Belgium

BOEING

Dear Sirs:

Subject: Boeing Service Bulletins for Mode S Elementary and Enhanced Surveillance

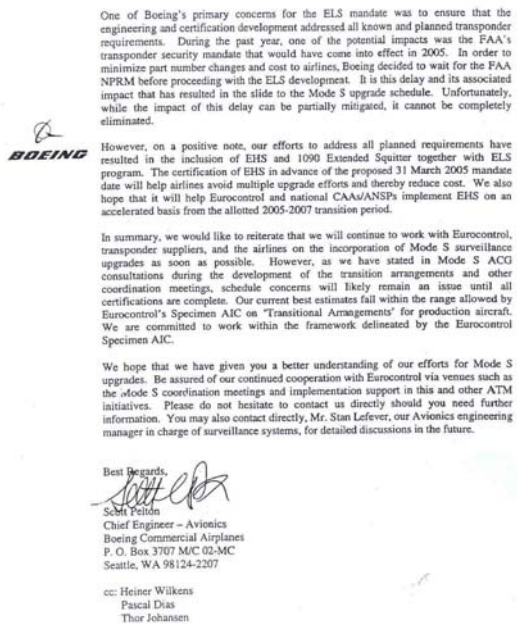
Thank you for your letter of 12 December 2002 on the subject of Elementary Surveillance (ELS) and Enhanced Surveillance (EHS) Service Bulletins (SB).

Boeing is aware of the airline impact of the SB availability dates and is making all efforts to make SBs available as soon as possible. However, as we have stated at previous Mode S coordination meetings, during the Mode S consultations on the transition period AIC and, the recent Eurocontrol Mode S Briefing Day on 26 November 2002, SB availability dates will continue to be an issue in progress. The best estimate for SB availability is 3Q/2003. We also expect to complete all certifications by March 31st, 2004 per the Eurocontrol AIC for 'Transitional Arrangements' for production aircraft.

By the way of background, we would like to briefly summarize our Mode S activities over the past two years within Boeing, industry groups, and especially Eurocontrol. Boeing has been working together with Eurocontrol, ARINC, and transponder suppliers in support of Eurocontrol's planned ELS/EHS programs. As part of this effort, we have established a very good working relationship with Eurocontrol's Mode S Program office and have a better understanding on how we can support the Mode S program plans.

In terms of implementation progress, we have certified transponders with partial ELS capabilities including SI code and RA Downlink. The only outstanding primary functionality is Flight ID. Flight ID requires a wiring change on most of our models and it is this functionality that will be certified on all models starting 3Q/2003.

In addition, we have prepared SBs for wiring partial provisions for ELS/EHS on all models. Airlines can implement ELS/EHS wiring SBs today and upgrade the transponder equipment when certified. Wiring provisions SB order-to-delivery cycles have also been reduced from 40-52 weeks to 25 weeks. We estimate to have activation SBs (i.e. equipment replacement) as short as 4 weeks after production certification provided that orders have been placed in advance. We are continuing to work with airlines on the schedule and content of the SBs and will apprise Eurocontrol of our progress on a continuous basis.



BOEING

One of Boeing's primary concerns for the ELS mandate was to ensure that the engineering and certification development addressed all known and planned transponder requirements. During the past year, one of the potential impacts was the FAA's transponder security mandate that would have come into effect in 2005. In order to minimize part number changes and cost to airlines, Boeing decided to wait for the FAA NPRM before proceeding with the ELS development. It is this delay and its associated impact that has resulted in the slide to the Mode S upgrade schedule. Unfortunately, while the impact of this delay can be partially mitigated, it cannot be completely eliminated.

However, on a positive note, our efforts to address all planned requirements have resulted in the inclusion of EHS and 1090 Extended Squitter together with ELS program. The certification of EHS in advance of the proposed 31 March 2005 mandate date will help airlines avoid multiple upgrade efforts and thereby reduce cost. We also hope that it will help Eurocontrol and national CAAs/ANSPs implement EHS on an accelerated basis from the allotted 2005-2007 transition period.

In summary, we would like to reiterate that we will continue to work with Eurocontrol, transponder suppliers, and the airlines on the incorporation of Mode S surveillance upgrades as soon as possible. However, as we have stated in Mode S ACG consultations during the development of the transition arrangements and other coordination meetings, schedule concerns will likely remain an issue until all certifications are complete. Our current best estimates fall within the range allowed by Eurocontrol's Specimen AIC on 'Transitional Arrangements' for production aircraft. We are committed to work within the framework delineated by the Eurocontrol Specimen AIC.

We hope that we have given you a better understanding of our efforts for Mode S upgrades. Be assured of our continued cooperation with Eurocontrol via venues such as the Mode S coordination meetings and implementation support in this and other ATM initiatives. Please do not hesitate to contact us directly should you need further information. You may also contact directly, Mr. Stan Lefever, our Avionics engineering manager in charge of surveillance systems, for detailed discussions in the future.

Best Regards,

Scott Pelton
Chief Engineer – Avionics
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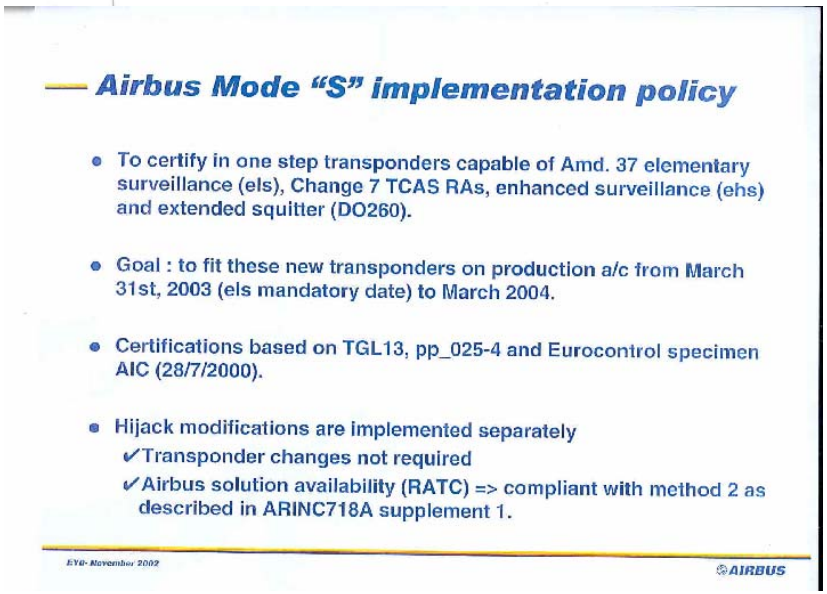
P. O. Box 3707 M/C 02-MC
Seattle, WA 98124-2207

cc: Heiner Wilkens
Pascal Dias
Thor Johansen

- Boeing and Airbus are committed to installing 1090 extended squitter on new aircraft deliveries
  - Airbus: Now
  - Boeing: March 2004

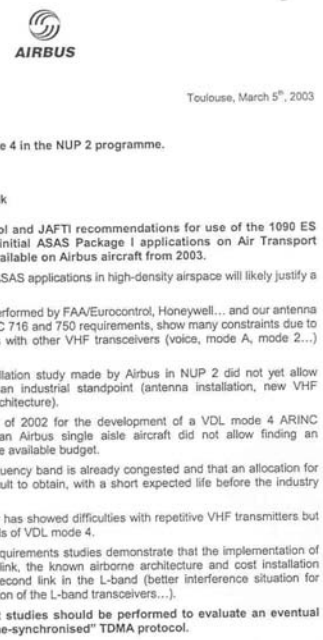


Airbus Mode "S" implementation policy

- To certify in one step transponders capable of Amd. 37 elementary surveillance (els), Change 7 TCAS RAs, enhanced surveillance (ehs) and extended squitter (DO260).
- Goal : to fit these new transponders on production a/c from March 31st, 2003 (els mandatory date) to March 2004.
- Certifications based on TGL13, pp_025-4 and Eurocontrol specimen AIC (28/7/2000).
- Hijack modifications are implemented separately
  - ✓Transponder changes not required
  - ✓Airbus solution availability (RATC) => compliant with method 2 as described in ARINC718A supplement 1.

EVE- November 2002

AIRBUS



AIRBUS

Toulouse, March 5th, 2003

Subject: Airbus position on VDL mode 4 in the NUP 2 programme.

1 Airbus position on ADS-B datalink

Airbus supports the FAA, Eurocontrol and JAFTI recommendations for use of the 1090 ES medium for the implementation of initial ASAS Package I applications on Air Transport Aircraft. 1090 ES capability will be available on Airbus aircraft from 2003.

Later on, the implementation of future ASAS applications in high-density airspace will likely justify a second link.

The first results from different studies performed by FAA/Eurocontrol, Honeywell... and our antenna isolation evaluation based on the ARINC 716 and 750 requirements, show many constraints due to VDL mode 4 radio interference issues with other VHF transceivers (voice, mode A, mode 2...) installed on the aircraft.

Based on these constraints, the installation study made by Airbus in NUP 2 did not yet allow finding an acceptable solution from an industrial standpoint (antenna installation, new VHF transceivers installation and avionics architecture).

The RFP issued by Airbus beginning of 2002 for the development of a VDL mode 4 ARINC transceiver for installation on-board an Airbus single aisle aircraft did not allow finding an acceptable solution that could fit into the available budget.

In addition, we know that the VHF frequency band is already congested and that an allocation for VDL mode 4 channels should be difficult to obtain, with a short expected life before the industry needs to find a more durable solution.

It should be noted that the study so far has showed difficulties with repetitive VHF transmitters but not difficulties with the STDMA protocols of VDL mode 4.

As a conclusion, if the performance requirements studies demonstrate that the implementation of ASAS applications require a second link, the known airborne architecture and cost installation issues lead Airbus to envisage the second link in the L-band (better interference situation for antennae installation, possible integration of the L-band transceivers...).

Therefore, Airbus recommends that studies should be performed to evaluate an eventual second link in the L-band using "time-synchronised" TDMA protocol.

Automatic Dependent Surveillance Broadcast (ADS-B) Roadmap

Phase 1 ADS-B Squit Only Applications

- ✓ Air Transport and General Aviation Avionics Available
- ✓ Prototype Ground Infrastructure (GBT) Mature, Production Cycle Initiated
- ✓ CommonARTS/STARS/MicroEARTS/ASDE-X Automation Upgrades Underway
- ✓ Services: Radar Like Separation in Non Radar Airspace; Gulf of Mexico Solution; Improved Surveillance

1999-2008

Phase 2 ADS-B Initial CDTI Applications

- Limited Display Applications Available for Air Transport; GA Product Mature
- Prototype Ground Infrastructure Mature, Production Baseline Changes
- Surface and Terminal Automation Completed (2006)
- Services: TIS-B; FIS-B; Enhance See and Avoid; Enhanced Visual Acquisition/Approach; Surface Moving Map; Surface Traffic Management; Initial Conflict Management

2001-2010

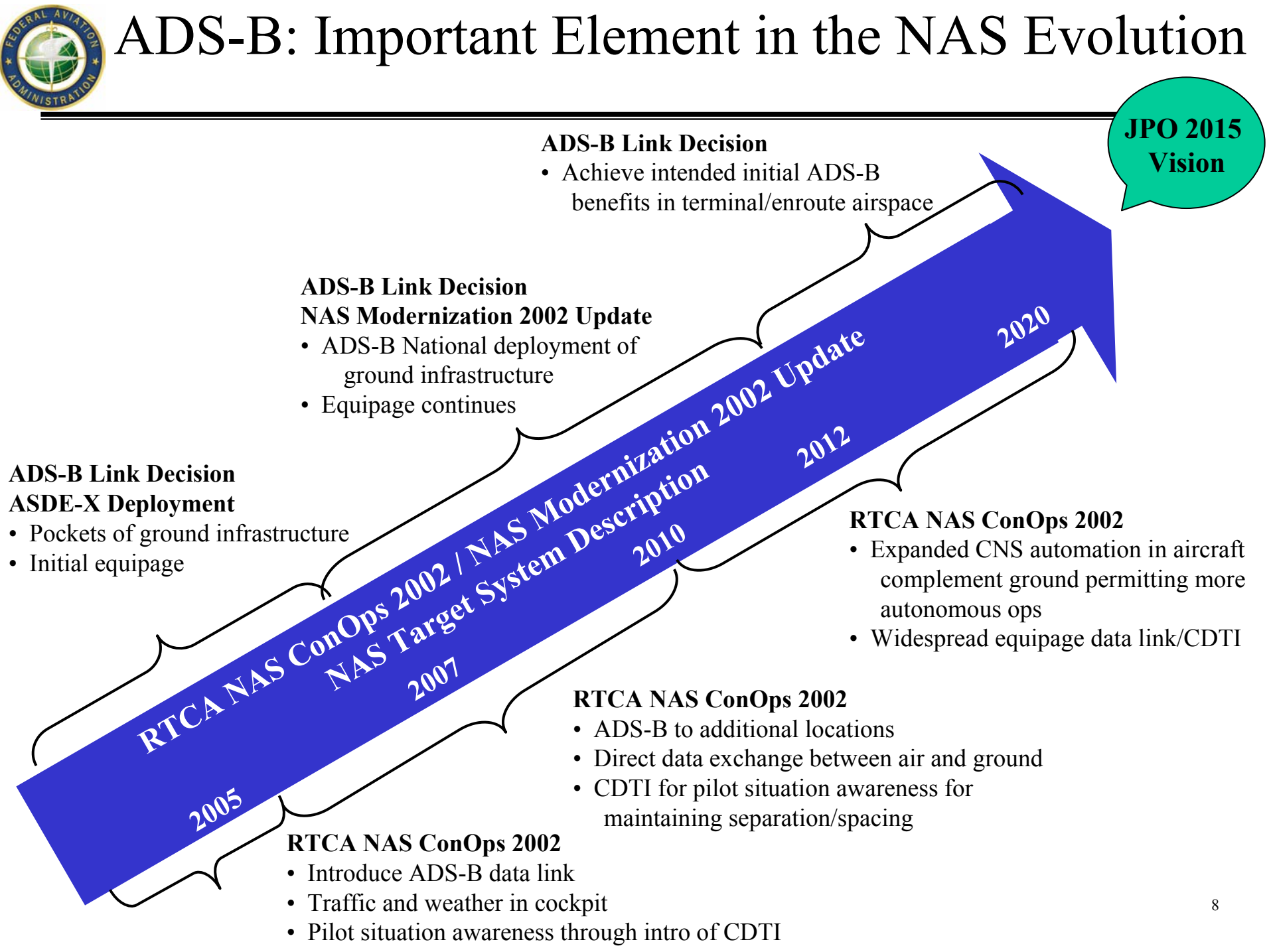
Phase 3 ADS-B Advanced CDTI Applications

- Air Transport and GA Products Display Products Available
- Production Ground Infrastructure Completed
- Surface, Terminal and En Route Automation Upgrades Completed
- Services: Advanced Applications With High Potential for Benefit; CEFR; Closely Spaced Parallel Approach; Seamless NAS

2005-2015

Eurocontrol Elementary Surveillance (ELS) Enhanced Surveillance (EHS)

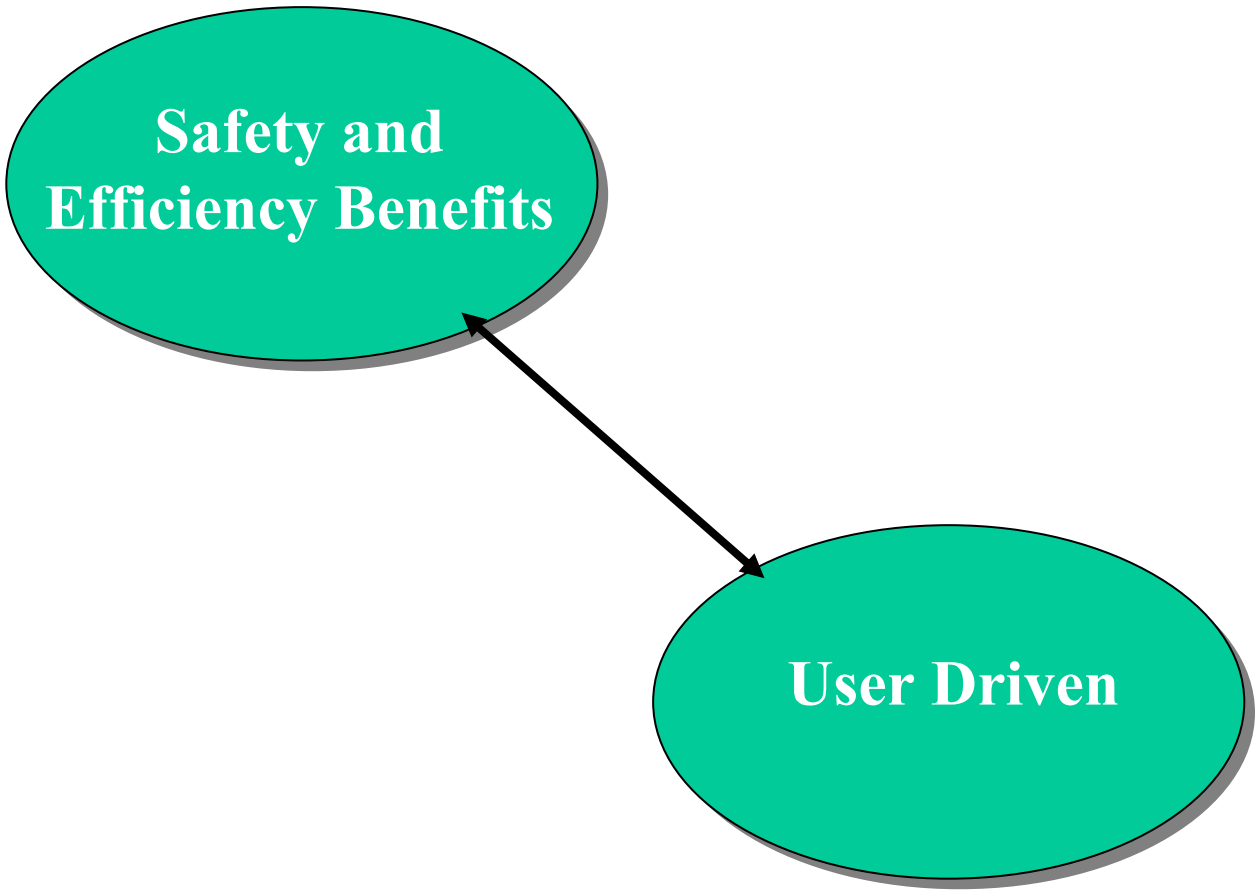
ADS-B: Important Element in the NAS Evolution



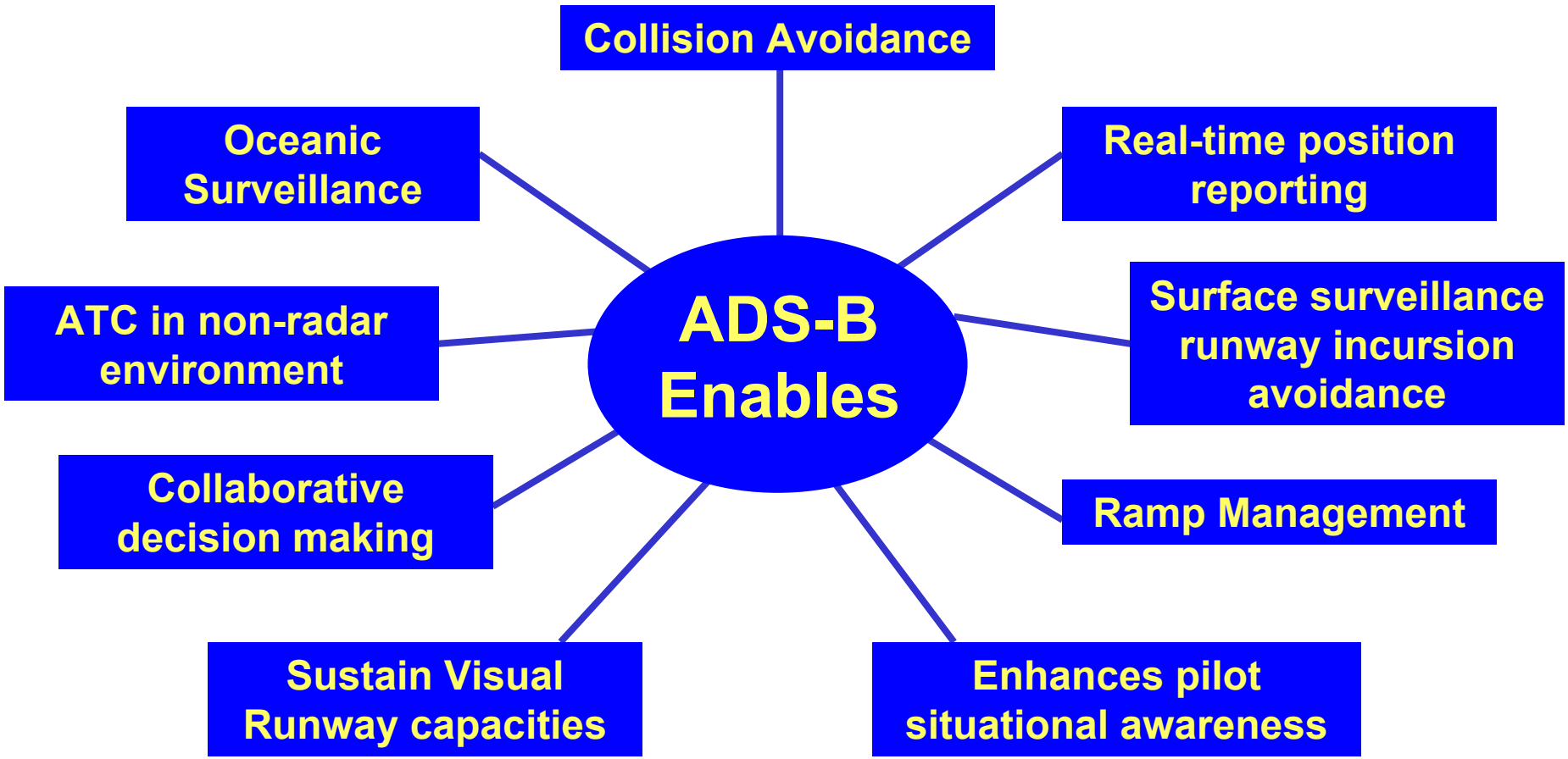
Global Perspective

- World is moving toward ADS-B
  - United States
  - Australia
  - Europe
    - Mandated Mode S elementary and enhanced surveillance
    - US collaboration on Work Package 1 applications

ADS-B Services Portfolio



ADS-B Potential Benefits

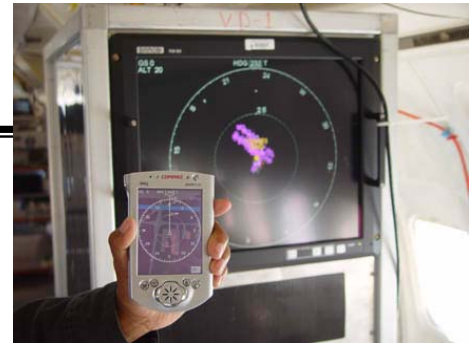


Surface Applications

Ramp Tower Display
Northwest at Detroit

Ramp Tower Display
FedEx at Memphis

Ramp Tower Display
UPS at Louisville



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DAB
MCO
TPA
SRQ
FXE
FLL
MIA
SJU
AFA
HNL
JNU
ANC

Maps posted to ftp://ftp.naco.faa.gov/
(47 to date)

Terminal Applications

Cockpit Display of Traffic Information (CDTI)

Range Indication

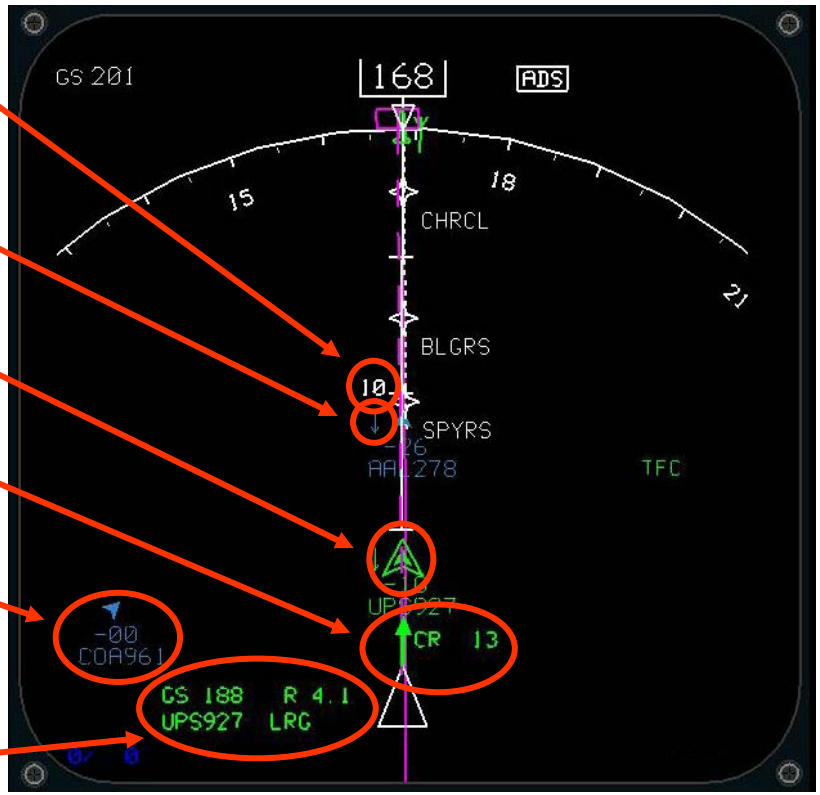
Climb/descent rate

Selected Target

Closure Rate

ADS-B Target & Call Sign

Selected Target Info



ADS-B Automation Integration

Micro-EARTS

Completed 2001

STANDARD TERMINAL AUTOMATION REPLACEMENT SYSTEM — STARS

On Contract

Common ARTS

On Contract

ERAM — The Solution for the New Millennium

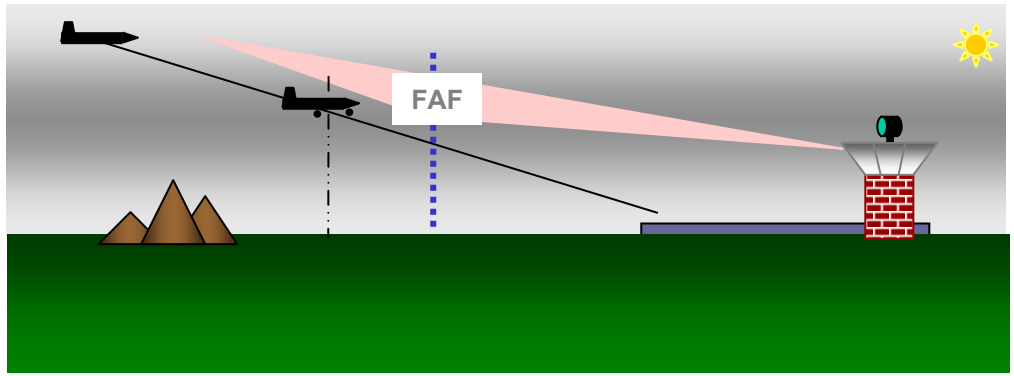
In Requirements Baseline

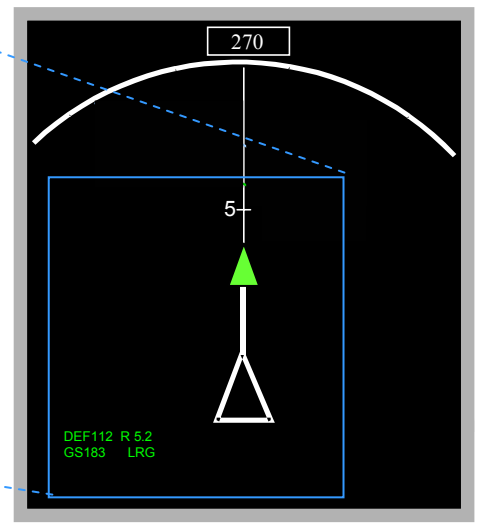
CDTI Enhanced Flight Rules (CEFR)

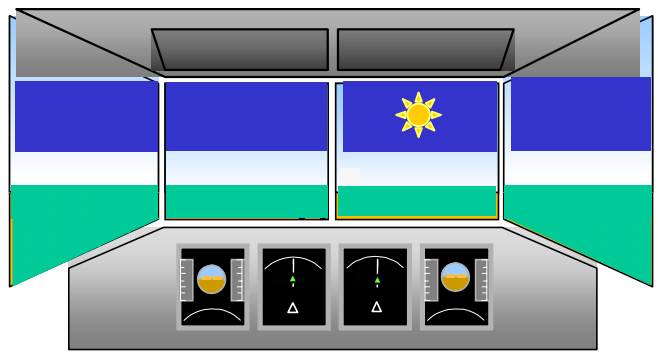
Future Concept

- ATC provides traffic advisory with call sign, if appropriate
- Initial visual out-the-window (OTW) acquisition and correlation with CDTI
- CDTI use during periods of lost visual contact *(haze, sun, other obscuration)*
- ATC provides vectors and speed instructions, as appropriate
- Increased opportunity for Visual Approach operations

Initial implementation conducted in VMC



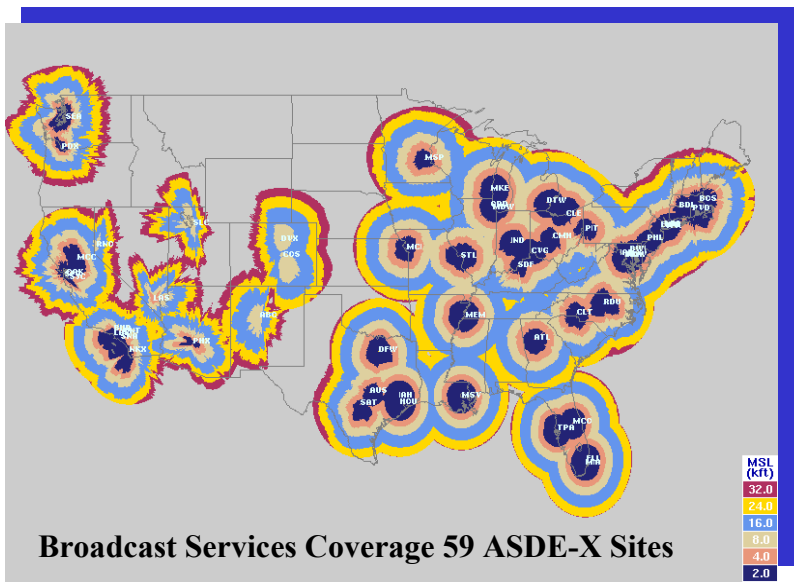




Flight Safety Applications
General Aviation Focus

ADS-B and broadcast services

- Capstone based avionics
- Dual strategy to implement broadcast services (TIS-B and FIS-B)
  - » Small airport infrastructure
    - > Establish test beds (Frederick MD/WJHTC/MITRE)
    - > Establish pockets of implementation (Prescott AZ/SATSLabs/**East Coast**)
  - » Leverage Airport Surface Detection Equipment Model X (ASDE-X) infrastructure (add broadcast services)



Broadcast Services Coverage 59 ASDE-X Sites

TIS-B - Traffic Information Service - Broadcast
FIS-B - Flight Information Services - Broadcast

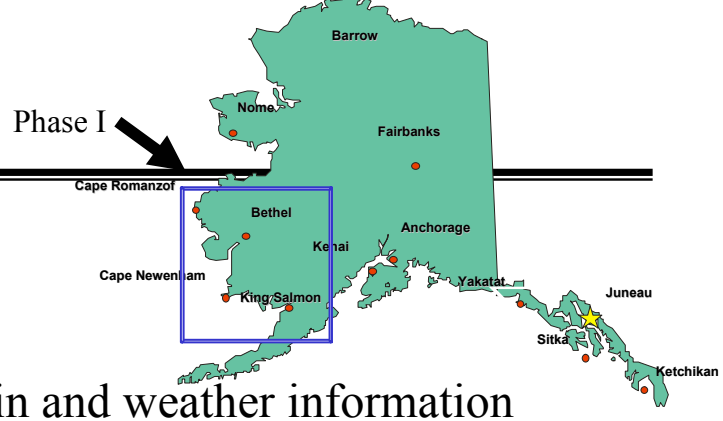
ADS-B Transition to Implementation

Pockets of Implementation

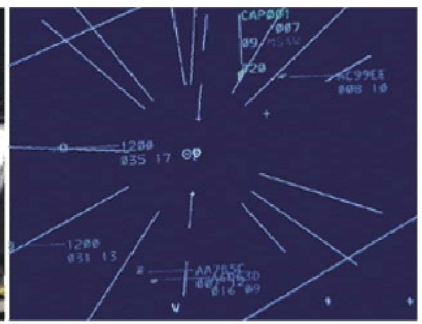
Address Specific User Needs

ADS-B Roadmap in Place

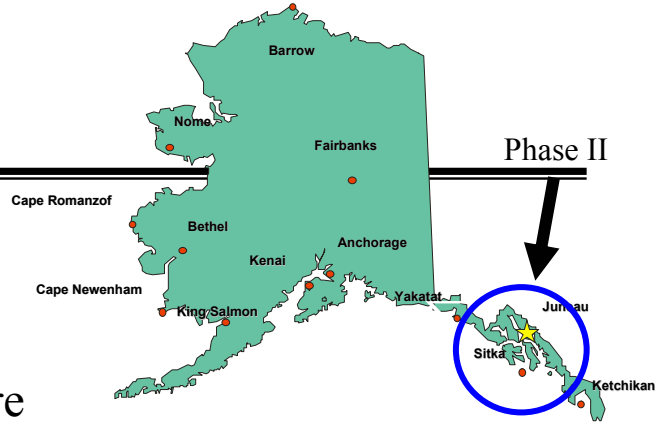
Alaska Capstone Program
Phase I (Bethel)



- Description
  - Seeking increased safety: surveillance, terrain and weather information
- Accomplishments
  - Integrated MicroEARTS and ADS-B
  - Equipped over 190 aircraft
  - Commissioned 11 ground broadcast transceivers
  - Radar-like capability from Anchorage Center
  - Automated Weather Observation Systems (AWOS) commissioned and GPS approaches published for 10 airports



Alaska Capstone Program
Phase II (Southeast)

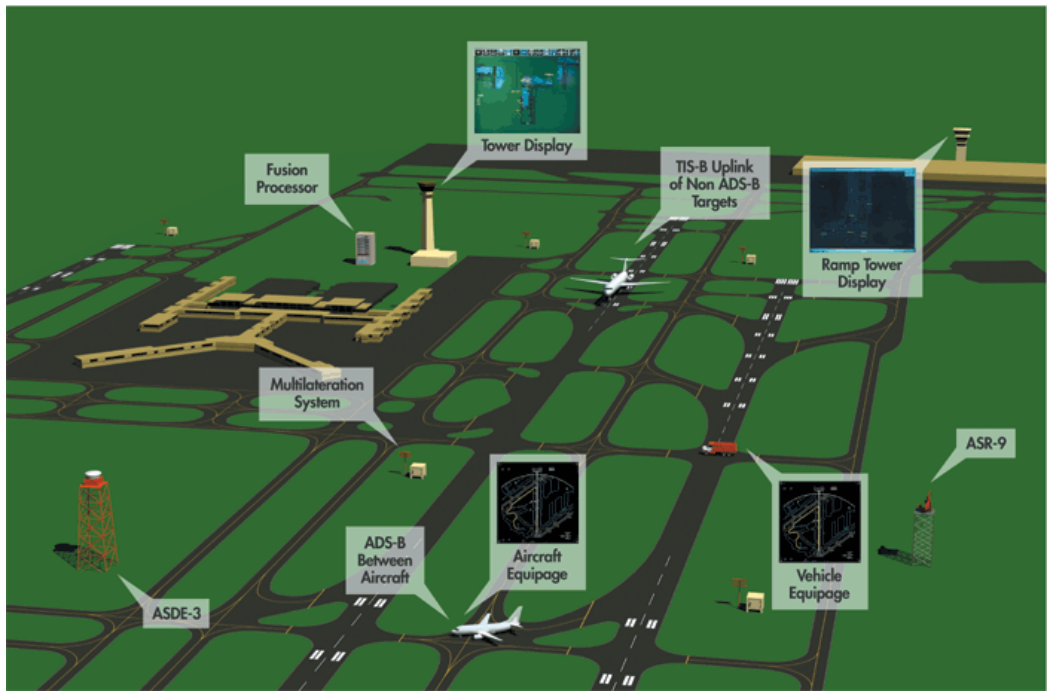


- Description
  - Seeking increased safety
  - Usable instrument flight rule (IFR) infrastructure
- Approach
  - Same capabilities as Phase I (surveillance, terrain, weather), upgrade to IFR
  - Purchase up to 200 advanced avionics sets
  - Install ground based transceivers initially in 14 locations
  - Improve voice communications in the Stephens Passage
  - Develop low level IFR en route and arrival/departure approaches
  - Develop multilateration airborne capability at Juneau

Chelton avionics certification "before and after"
University of Alaska C-172 provisional STC installation

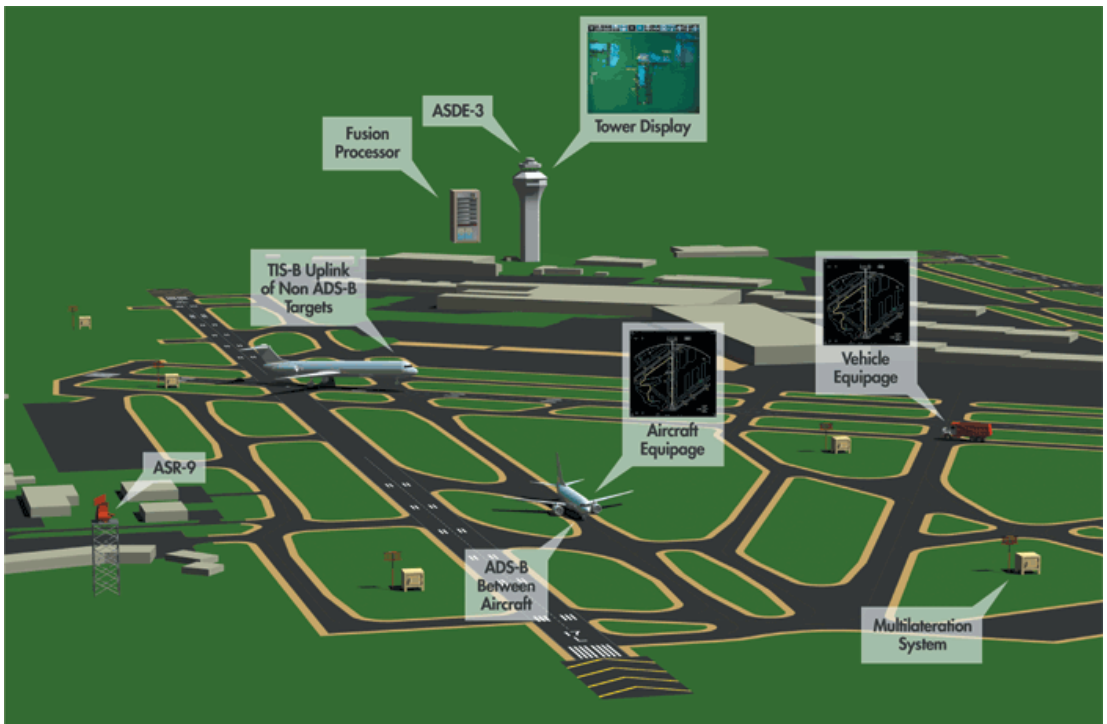
Safe Flight 21 Test Bed: Memphis, TN

- Prototype Airport Surface Detection Equipment Model X (ASDE-X)
- ADS-B/Standard Terminal Automation Replacement System (STARS) integration key site
- Test infrastructure for Surface Management System (SMS)
- Vehicle tracking surface moving map



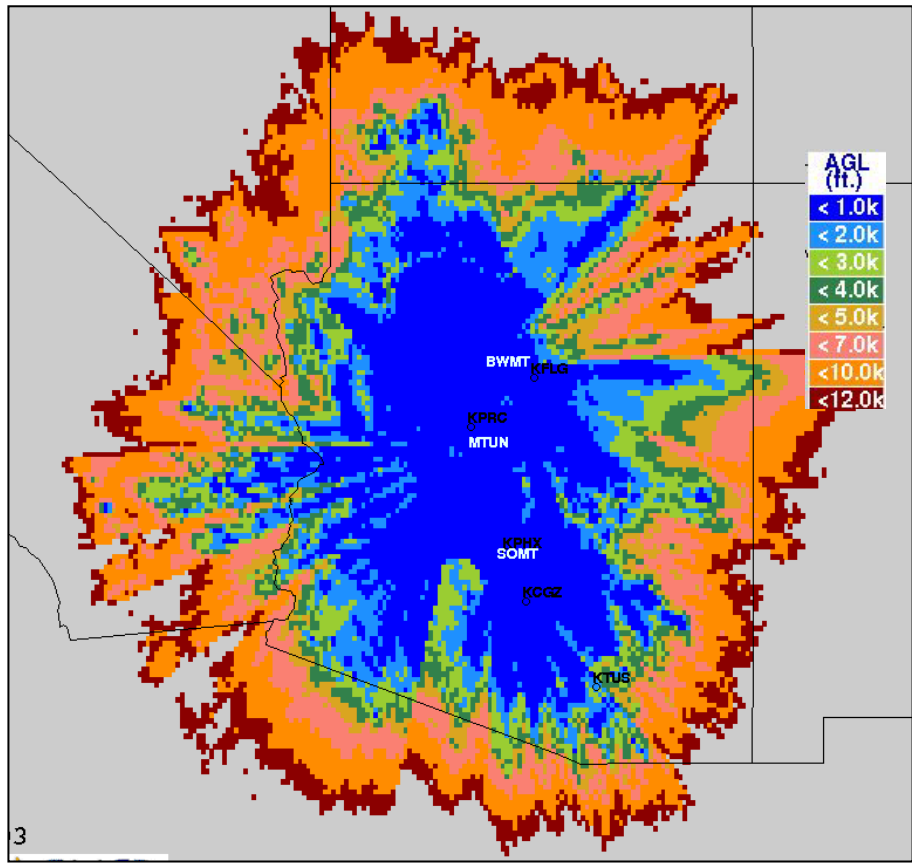
Safe Flight 21 Test Bed: Louisville, KY

- Pre-production Airport Surface Detection Equipment Model X (ASDE-X)/multilateration system
- ADS-B/Common Automated Radar Terminal System (ARTS) integration key site
- ADS-B avionics being installed on 107 UPS aircraft
- Test infrastructure for Surface Management System (SMS)
- Vehicle tracking surface moving map



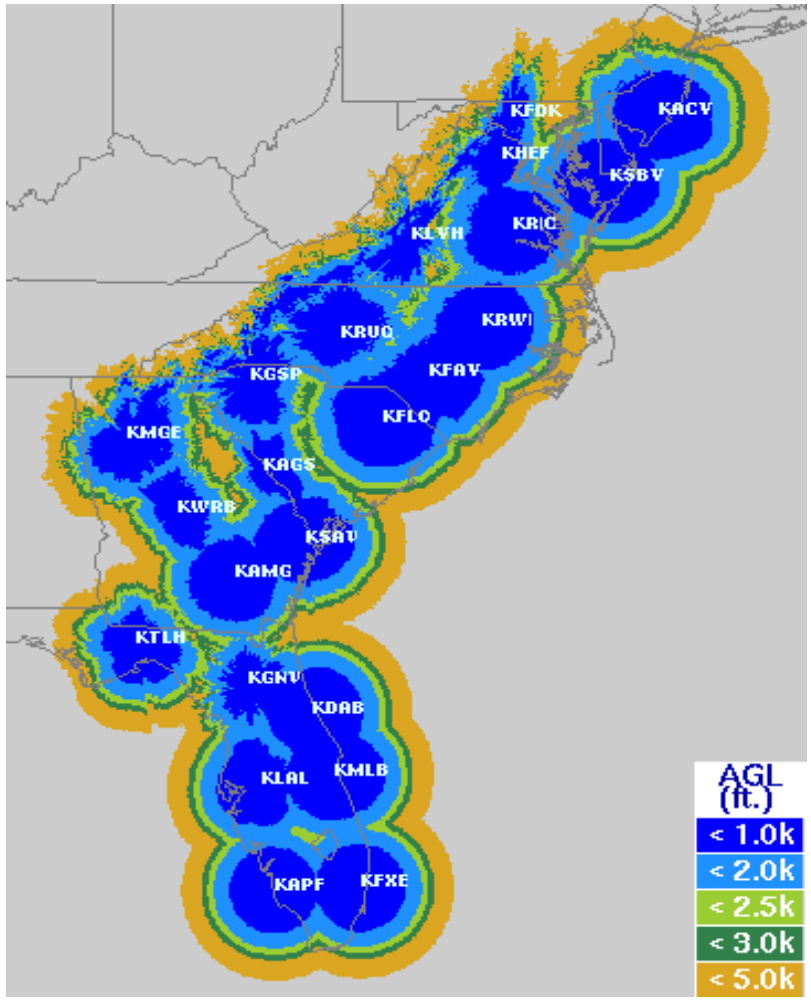
ADS-B in Prescott, AZ

- Embry-Riddle Aeronautical University (ERAU), Prescott requested FAA support in establishing an ADS-B functionality
- Agreement with ERAU Prescott signed: January 2003
  - ERAU to procure, install, and maintain ADS-B avionics
  - FAA to procure/maintain ADS-B ground infrastructure
- ERAU ordered 104 UPSAT MX-20 ADS-B ship sets: April 1, 2003
  - (Prescott, AZ and Daytona Beach, FL)



East Coast Infrastructure INTERIM COVERAGE

- Provide ADS-B and broadcast services along U.S. east coast from Florida to New Jersey
  - Interim ground infrastructure (no ATC feed)
  - Free broadcast services
  - Forward-compatible with avionics
  - Siting based on user demographics
  - Control facility and test bed at WJHTC
  - IOC by end of CY 2004

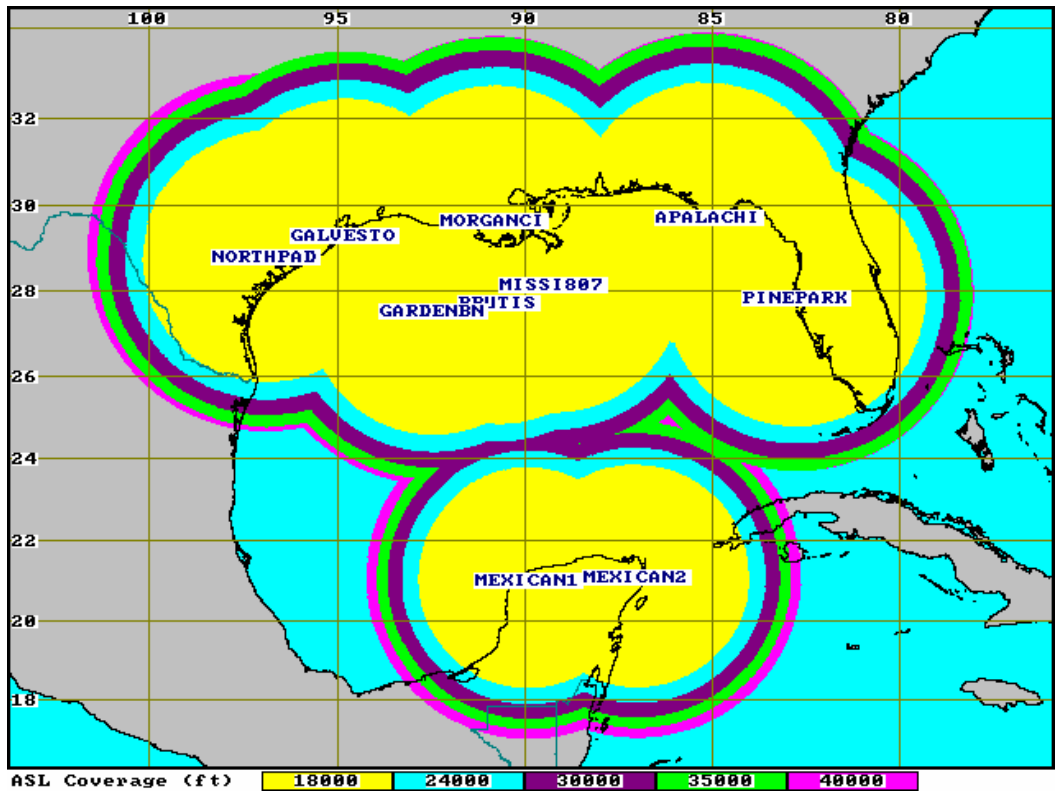


Stimulate production and equipage of ADS-B avionics!

ADS-B Coverage Overview and Mexican Radar Airspace

Apply and/or develop ADS-B technologies to meet user needs in the enroute, off-shore, and oceanic environments with end goal of NAS wide implementation.

- Leverage NASA HITS technology
- Close collaboration with SW Region and Gulf user community
- Identify and pursue synergisms with the GCNSS Team (Satellite-based communications)
- Coordinate activities with enroute and oceanic programs (e.g. ERAM, ATOP)
- Install equipment and conduct operational tests
- Identify automation requirements (MicroEARTS, ERAM, ATOP, HOST)
- Identify voice communication solution (Below FL240, VERN Upgrade)
- Investment Analysis Decision - May 04



Closing Remarks

- Over past 4 years ADS-B foundation put in place
  - Avionics…Ground Infrastructure…Automation
- Service Portfolio
  - Today: Radar like services…Enhanced Visual Approach…Surface Management…FIS-B…TIS-B
  - Future: CEFR, Closely Spaced Parallel Approach, Seamless NAS
- Interested in other “user pull” pockets to solve specific needs/services